

Origin of Collectivity in Non-central Heavy Ion Collision*

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The collectivity in the non central heavy ion collision has been observed in the several experiments. Result from the experiments shows the sign of v_2 changes with the lab energy. It means at different energy, the mechanism to produce the elliptic flow is different. The v_2 sign at the 2GeV AGS is negative, while the lab energy increases, v_2 becomes positive. At the low energy, the nuclear shadowing dominates the collectivity, so v_2 comes from the squeeze out; higher the lab energy is, the closer the system is to the hydrodynamic system, so at high energy, the pressure gradient should become more important.

The observed flow at both AGS ($\sqrt{s} = 5\text{GeV}$) and SPS ($\sqrt{s} = 17\text{GeV}$) confirmed the hydrodynamical conjection. However, it has not been shown that the pressure gradient could be built-up and lead to the flow. In this report, we use the transport model RQMD to evaluate the pressure gradient as a function of collision time with respect to the azimuthal angle.

We use 813 RQMD (v2.4) events to simulate the non-central ($b=7\text{fm}$) Au+Au collision at RHIC energy. The energy momentum tensors are calculated, the pressure, energy density, and flow velocity are extracted from the tensor. Based on these information, the pressure gradient as function of transverse radius at different time slices is computed.

In Figure 1, at the very early time ($0.5\text{fm}/c$), pressure gradient along x direction is larger than one along y. The larger pressure gradient at x direction (the impact parameter direction) causes that the flow velocity along x direction builds up faster than one along y, there is more expansion along x, which leads positive v_2 . The in-plane pressure gradients are stronger than that of the out-of-plane ones which is the basic driving force of the observed positive v_2 values in high energy

nuclear collisions. When we measure the transverse momentum of these events, we find the average transverse momentum along x is larger than one along y. Both of v_2 and transverse momentum can be observed by experiments, these mean maybe from the experiment measurement we can get some information on the pressure gradient at the early state of the system¹.

The whole picture is consistent with the hydrodynamic picture. Larger pressure gradient leads to the more expansion. But in this system, there are still other factors which we are interested in.

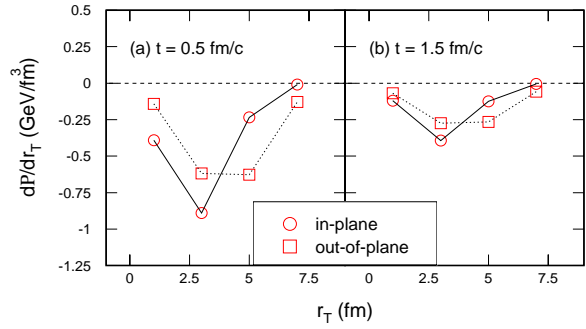


Figure 1: *Pressure gradient as a function of collision time and reaction plane. The in-plane and out-of-plane pressure gradients are represented as open circles and open squares, respectively. (a) at the collision time $t = 0.5\text{ fm}/c$; (b) at the collision time $t = 1.5\text{ fm}/c$. Particles from the RQMD(v2.4) Au+Au (at $\sqrt{s} = 200\text{ AGeV}$) events with impact parameter $b = 7\text{ fm}$ collisions were used.*

Footnotes and References

*Collaboration with Y. Pang and N. Xu

Footnotes and References

¹Q. Li, Y. Pang, and N. Xu, *Origin of Collectivity at Heavy Ion Collisions*, to appear in Nucl. Phys. A.